980 Ninth Street, Suite 1500
Sacramento, CA 95814
www.deltacouncil.ca.gov

Lead Scientist's Report

Summary: This report includes five items: (1) a summary of an article from *San Francisco Estuary and Watershed Science* on managing resilient salmon populations in California; (2) a summary of an article from *Limnology and Oceanography* on the value of long-term environmental data and water quality trends in the upper San Francisco Bay; (3) a summary of the 2018 Bay-Delta Science Conference; (4) a summary of the recent Salinity Symposium; and (5) By the Numbers Report.

Managing for Salmon Resilience in California's Variable and Changing Climate. Herbold, Bruce; Carlson, Stephanie M.; Henry, Rene; et al. *San Francisco Estuary and Watershed Science*. August 2018.

Historically, salmon in California had access to many diverse and complex habitats, including a wide range of different spawning and rearing habitats. This wide range of habitat conditions led to high genetic diversity in salmon populations, making them more resilient to California's naturally dynamic climate. Human activities and modifications (e.g., logging and other land use changes, and the construction of levees, dams, and diversions) have simplified and greatly reduced available salmon habitat. Additionally, reservoir operations have stabilized natural variability in hydrology, affecting temperature and flow conditions downstream. Loss of habitat complexity, combined with hatchery practices, has greatly reduced the genetic diversity of Central Valley salmon. As a result, salmon populations are less resilient to environmental stressors and more vulnerable to extinction.

In September 2015, the Delta Science Program and the University of California, Davis, held a symposium to identify management approaches to assist with recovery and resiliency of salmon populations in California's variable and changing climate. This synthesis paper summarizes the findings from the 2015 workshop, and emphasizes the importance of restoring habitat diversity to improve salmon resilience to environmental stressors, including climate change. The authors identified four management approaches that can facilitate salmon recovery and resilience: 1) improving access to upstream habitats; 2) reducing stresses associated with water temperature and food availability; 3) maintaining conditions to support a mix of life-history stages; and 4) improving approaches to artificial propagation.

Upstream access can be improved by the removal of barriers, construction of fish passage structures, and, as a last resort, trap-and-transport methods. Reducing warm-season water temperatures (e.g., reservoir releases and habitat restoration to create thermal refuges) and improving food web support (e.g., tidal marsh restoration and increased access to floodplains and rice fields) will allow fish to put more energy into growth and reproduction than into dealing with environmental stressors. A mosaic of aquatic habitats could be reestablished to promote a diversity of life-history stages, and hatcheries can adjust their practices to promote genetic diversity of salmon populations. Together all of these actions could collectively strengthen salmon in the Central Valley.

Patterns, Pace, and Processes of Water-quality Variability in a Long-studied Estuary. Cloern, James E. *Limnology and Oceanography*. Available on-line August 2018.
Long-term environmental time series data (repeated observations over time) are critical to detect and understand changes in environmental conditions and to develop strategies for the management and mitigation of change. The iconic example of this is the long-term measurements of atmospheric carbon dioxide (CO_2) concentrations from Mauna Loa, Hawaii, which were initiated in the late 1950s, showing early warnings of climate change and continued evidence of atmospheric changes associated with the burning of fossil fuels.

Dr. Jim Cloern from the U.S. Geological Survey in Menlo Park has employed this approach of long-term time series analysis to examine water quality conditions in the upper San Francisco Bay. He used 42 years of monthly measurements collected by the Interagency Ecological Program's (IEP) Environmental Monitoring Program and conducted a suite of analyses to extract multiple insights from the dataset.

He found that changes in water quality parameters (e.g., ammonium, water clarity, and chlorophyll *a* [a measure of phytoplankton biomass]) occurred across every time scale, from the entire 42-year study period to annually and seasonally. These changes were strongly tied to both variability in flow and human activities (e.g., damming, diversions, species introductions, and policy implementation). For instance, Chlorophyll *a*, a good index of lower food web support, decreased by 74 percent during the 42-year study period, with the largest decreases occurring in summer. His results highlight the fast-paced changes occurring in the upper San Francisco Bay and the large human influence over estuarine dynamics in the region. Utilizing long-term data and syntheses such as this is essential for improving our understanding of these dynamic systems, and this knowledge will improve forecasting of ecosystem changes and related management decisions into the future.

2018 Bay-Delta Science Conference Summary
The 10th Biennial Bay-Delta Science Conference (BDSC) was held Sept. 10–12, 2018, at the Sacramento Convention Center. The conference lived up to its title, "Our Estuary at an Intersection," focusing on the intersection and collaboration of several different disciplines, including natural science, social science, art, and communication.

The conference was well attended, with 1,025 attendees from government agencies (64 percent), academia (21 percent), the private sector (11percent), and elsewhere. For a third of the attendees, this was their first BDSC experience. The vast majority of attendees that responded to a post-conference survey (97 percent) stated that the conference was either "Excellent" or "Good". Respondents also indicated that the:

- Mentor Lunch was valuable (77 percent),
- "Art and Science Exhibits" were enjoyable (73 percent),
- Science communication training was valuable (85 percent), and
- The poster session was either good or excellent (93 percent).

The conference remains one of the best opportunities for the regional science and management communities to share and absorb recent science results, build relationships, and enhance communications skills. It is a reminder of how many talented and passionate people devote their careers to understanding and improving conditions in the Bay-Delta system. In their evaluation of the Conference, the Delta Independent Science Board, stated that "the information contained

in the plenaries, regular sessions, and poster sessions substantially advanced science in and about the Bay-Delta, and highlighted its growing relevance to issues statewide and beyond. The biennial Bay-Delta Science Conference continues to compare favorably to major national and international conferences in scientific quality."

Ecological and Physiological Impacts of Salinization of Aquatic Systems from Human Activities Symposium

In the Bay-Delta estuary, fresh water from rivers in the watershed meets salt water from the ocean just upstream of Suisun Bay. The varying river flows and changes in tides naturally affect salinity levels, but human activities have caused salinity levels to shift upstream over time. Changing salinity levels are increasingly being recognized as an emerging problem in the Bay-Delta system, with impacts on water exports, agriculture, species of concern, and species with economic and recreational benefits.

On September 26, 2018, the Delta Science Program and the UC Davis Coastal and Marine Sciences Institute co-hosted a symposium focusing on evaluating how changing salinity regimes affect the Bay-Delta ecosystem. The day began with a discussion of drivers affecting salinity levels. Salt levels in the Bay-Delta estuary have been increasing over the last 100 years, and the main drivers of this increase are flow conditions (less Delta outflow), physical changes (deepening, widening, and straightening of Delta channels), and climate change (sea-level rise). The remainder of the day focused on the estuarine environment and the physiological and evolutionary responses of estuarine species to increased salinity levels. Speakers represented diverse perspectives and fields including hydrology; plant and fish physiology; genetics; evolutionary biology; restoration; historical ecology; modeling; and policy. One recurring theme throughout the symposium was the importance of integrating across these different disciplines to fully understand the effects and management opportunities associated with changing salinity levels in the Bay-Delta.

The day following the symposium, invited speakers and organizers convened for a one-day workshop to review key messages and outline a paper that will synthesize findings from the event. A recording of the symposium, the agenda, and speaker biographies can be found on the CMSI website here: https://marinescience.ucdavis.edu/engagement/past-events/salinization-symposium-2018

By the Numbers

Delta Science Program staff will provide a summary of current numbers related to Delta water and environmental management. The summary (Attachment 1) will inform the Council of recent counts, measurements, and monitoring figures driving water and environmental management issues.

List of Attachments

Attachment 1: By the Numbers Summary (report to be provided at the Council Meeting)

Contact

Dr. John Callaway
Lead Scientist
Phone: (916) 445-0463